RK UNIVERSITY

SYLLABUS

Course Title	COMPUTATIONAL FLUID DYNAMICS
Course Code	TH211
Course Credit	Lecture : 04
	Practical : 01
	Tutorial : 00
	Total : 05

Course Learning Outcomes

At the end of the course the students will be able to

- **Understand** about SIMPLE and MAC algorithm for computational methods and apply the same in various turbulent models.
- **Develop** a detailed understanding of the analytical approaches and numerical procedures currently used in modern CFD software.
- **Understand** Physical meaning of the governing equations of continuity, momentum and energy thereby developing the platform to solve these partial differential equations with the use of analytical methods or the specialized software like ANSYS, FLUENT etc.
- **Understand** and learn the basic Discretization techniques involved in computational modeling and be able to apply them to simple benchmark problems and understand the concept of validation.
- **Understand** and analyze the various simplified models of turbulent fluid flow using specially developed algorithms.

Detailed Syllabus

Sr. No.	Name of chapter & Details	Hours Allotted
	SECTION-I	
1	**Introduction & Basic concepts:** • Introduction of CFD, Types of fluids and basic equations of flow, Conservation of mass, Newton's Second law of Motion. • Governing equations of fluid flow, Navier-Stokes equations, Boundary layer equations. • Expanded form of N-S equations, Conservation of energy principle. • Special form of N-S equations, Classification of second order partial differential equations, Initial and boundary conditions. • Governing equations in generalized coordinates. Review of essentials of fluid dynamics.	14

2	**Finite difference methods.** • Differential Equations & Discretization: Elementary Finite Difference Equations. • Basic aspects of Finite Difference Equations, Errors and Stability Analysis. • Discretization, Application to heat conduction and convection, Problems on 1-D and 2-D steady state and unsteady state conduction. • Problem on Advection phenomenon, Incorporation of Advection scheme.	**14**
	Total	**28**
SECTION-II		
3	**Finite Element Method**. • Introduction to Finite Element Philosophy. • Basics of finite element method, • Stiffness matrix, isoperimetric elements, formulation of finite elements for 1-D & 2-D flow& heat transfer problems.	**9**
4	**Finite Volume Method** • Introduction to Finite Volume Philosophy. • Integral approach, Discretization & higher order schemes. • Application to Complex Geometry.	**8**
5	**SIMPLE and MAC algorithm** • Introduction to solutions of viscous incompressible flows using MAC & Simple algorithm.	**4**
6	**Incompressible fluid flows and Turbulence models** • Governing equations of viscous incompressible flows by stream function, vorticity formulation. • Two dimensional incompressible viscous flows. • Turbulence, Effect of Turbulence and time averaged Navier stokes Equation, Algebric Models – One equation model, k-e models, algebraic stress model.	**7**
	Total	**28**

Instructional Method and Pedagogy:

- At the beginning of course, the course delivery pattern, prerequisite of the subject will be discussed.
- Lectures will be conducted with the aid of multi-media projector, blackboard, OHP etc.
- Attendance is compulsory in lectures and laboratory.
- Minimum two internal exams will be conducted and average of two will be considered as a part of overall evaluation.
- Assignments based on course content will be given to the students at the end of each unit/topic and will be evaluated at regularly.
- Surprise tests/Quizzes/Seminar/Tutorials will be conducted.
- The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures.
- Tutorials and assignments are to be submitted as term-work in laboratory related to course contents.

Reference Books:

1. Anderson D.A., Tannehilj.c.Pletcher R.H.” Computational fluid mechanics & heat transfer” Hemisphere publishing corporation,. Newyork, U.S.A2004.
2. Anker S.V., “Numerical heat transfer & flow” Hemisphere corporation, 2001
3. H.K.verstag&W.Malalsekra,” An introduction to computational fluid dynamics Longman-2000
4. Carnahan B, “Applied numerical method” John Wiley & Sons-2001.
5. Patankar, “ Numerical heat transfer & Fluid Flow”, Mc.GrawHill.,2002
6. Murlidhar K., Sunderrajan T., “Computational Fluid Mechanics and Heat Transfer” Narosa Publishing House.
7. Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer-Verlag, 1987.
8. Bose,T.K.,"Numerical Fluid Dynamics" Narosa Publishing House, 1997.
9. Date A. W., “Introduction to Computational Fluid Dynamics”, Cambrige Uni. Press, 2005
10. Ferziger J. H., Peric M., “Computational Methods for Fluid Dynamics”, Springer, 2002.